

A NEW SPECIES OF *CORVASPIS* (AGNATHA, HETEROSTRACI) FROM THE UPPER SILURIAN TO LOWER OR MIDDLE DEVONIAN OF THE NORTH-WEST TERRITORIES, CANADA

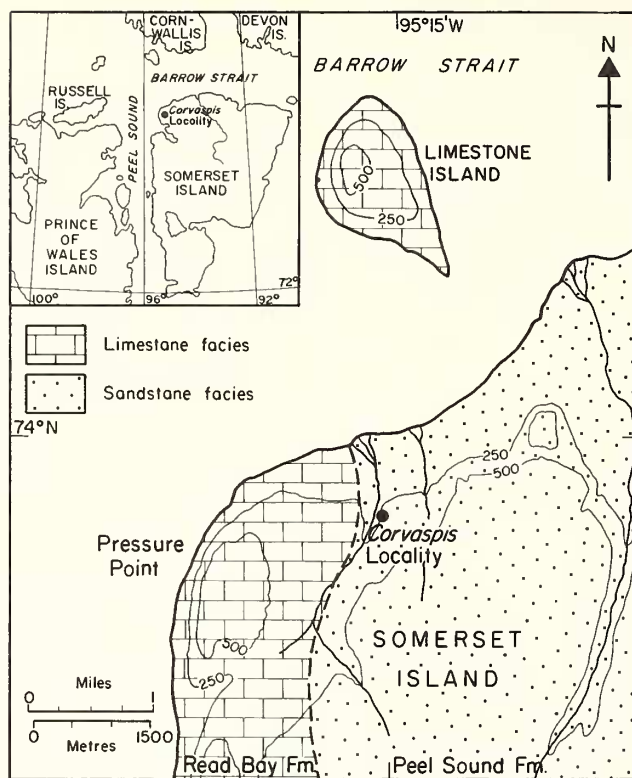
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ABSTRACT. A new species of *Corvaspis*, *C. arctica*, is described from the Peel Sound Formation of Somerset Island, North-west Territories, Canada, where it occurs in association with *Hemicyclaspis munchisoni* (Egerton), an index fossil for the lowest Downtonian of Britain. *C. arctica* sp. nov. is considered to have been a streamlined form, with an undivided dorsal shield; it is probably related to the Cyathaspididae.

DURING the mid 1960s a large amount of ostracoderm material was collected from the Peel Sound Formation of Somerset and Prince of Wales Islands in Arctic Canada by members of the University of Ottawa (Dineley 1965*a* and *b*, 1966*a* and *b*). Detailed descriptions of much of this material have now been published (Dineley 1968 and in press; Broad and Dineley 1973; Broad 1973), or included in theses (Broad 1968, 1971). Of the remaining material, three specimens of *Corvaspis* have been selected for description here because they contribute to the continuing debate on the affinities of the genus.

The three specimens (NMC 21600–21602) were collected in 1965 by one of the authors (D. L. D.), from a band of white sandstone approximately 12 m above the floor of a stream gorge, immediately east of the hill at Pressure Point, on the north-western tip of Somerset Island (text-fig. 1). The same locality also yielded two articulated specimens of *Hemicyclaspis munchisoni* (Egerton), large and small cyathaspidids, traquairaspidids, and acanthodians (Dineley 1968). *H. munchisoni* is regarded as an index fossil for the lowest Downtonian of Britain (White 1950); such a stratigraphic designation (now accepted as equivalent to the early Pridolian Stage) was considered by Dineley (1968) as in accord with the position of the ostracoderm horizon, which is an estimated 15–18 m above the base of the Peel Sound Formation. This locality is approximately 20 km west of that from which Thorsteinsson and Tozer (in Fortier *et al.* 1963) reported two new genera of cyathaspidid, one of which was said to compare favourably with *Corvaspis* (*ibid.*, p. 122); these specimens have not yet been figured or described.

The specimens described below represent only a small part of the *Corvaspis* material present in the collections from Somerset Island, or indeed from the same locality; fragmentary *Corvaspis* plates occur in a blotchy sandstone unit 3 m lower in the section. No attempt is made here to describe the rest of the material from this locality; it includes orbital, lateral, and medial fragments, which vary in size and ornamentation, but contribute little to our knowledge of *Corvaspis*.



TEXT-FIG. 1. Locality map.

SYSTEMATIC PALAEOLOGY

The ostracoderms with which this paper is concerned are the property of the National Museum of Canada, Ottawa, and bear the catalogue numbers (prefixed NMC) of that institution.

Order HETEROSTRACI Lankester, 1868

Family CORVASPIDIDAE Dineley, 1953

Genus CORVASPIS Woodward, 1934

Corvaspis arctica sp. nov.

Plate 114; text-figs. 2-4

Derivation of name. The specimens are from Arctic Canada.

Diagnosis. Dorsal shield long (90 mm) and narrow (width ratio = 0.44), completely enclosing orbits. Ornamentation of short (1-10 mm), closely spaced, smooth-topped, dentine ridges, 0.2-0.5 mm wide and of uniform height. Superficial units, 1.0-3.0 mm long and 1.0-4.0 mm wide, produced by local grouping of dentine ridges; anterior units with peripheral ridges curved around median ridge, posterior units scale-like, and intermediate units with parallel ridges.

Holotype. NMC 21600, incomplete dorsal shield (Pl. 114, fig. 1; text-fig. 2).

Other material. NMC 21601 (Pl. 114, fig. 2; text-fig. 3); NMC 21602 (Pl. 114, fig. 3; text-fig. 4), incomplete dorsal shields.

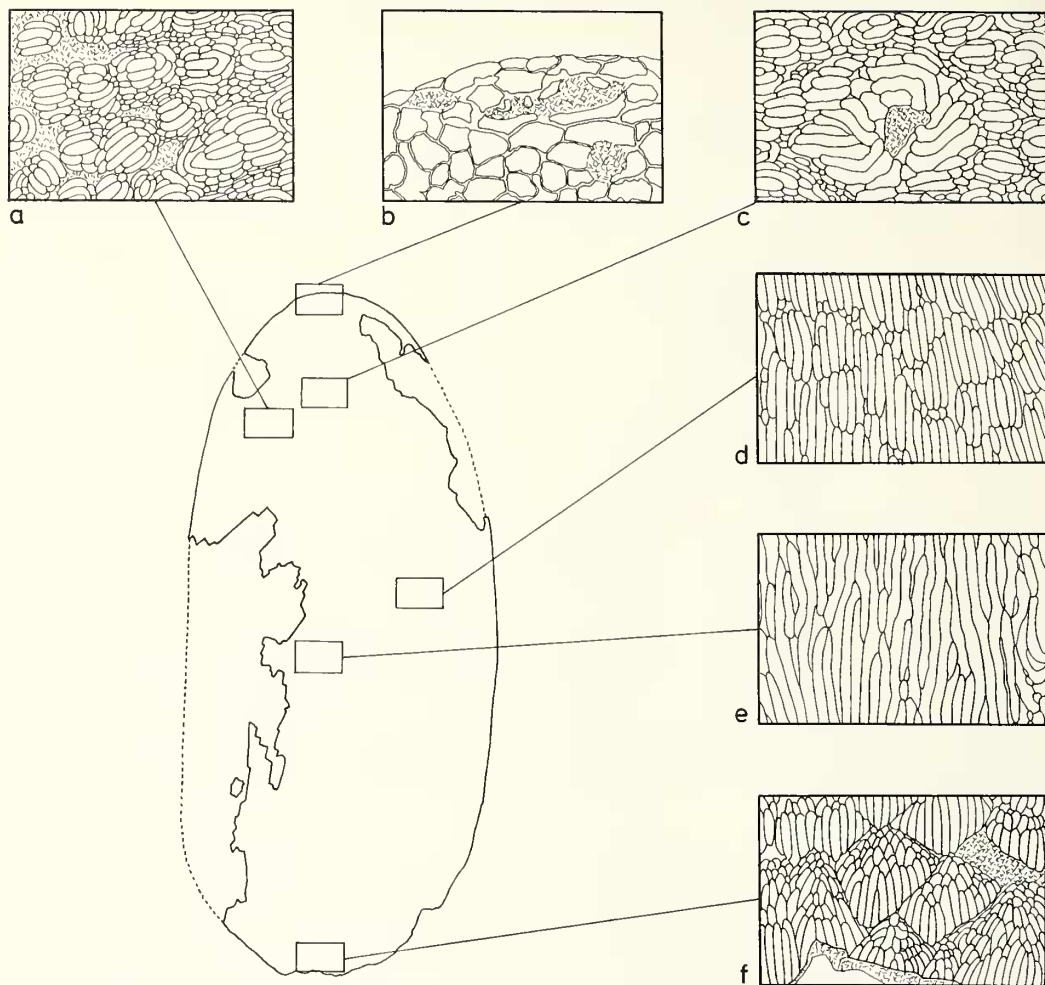
Locality. 12 m above floor of gorge east of Pressure Point, N.W. Somerset Island.

Description. Dimensions of dorsal shields (using those parameters measured by Denison (1966) in the Cyathaspididae):

	NMC 21600	NMC 21601
Median length	90 mm	—
Maximum width	40 mm	—
Pineal length	14 mm	—
Orbital width	21 mm	21 mm
Orbital length	9 mm	7 mm
Width ratio	0.44	—
Pineal length ratio	0.16	—
Orbital width ratio	0.23	—
Orbital length ratio	0.10	—

The long, narrow dorsal shield has a smoothly rounded rostral margin and an irregular posterior margin. The pineal macula, which is well preserved in NMC 21602, but abraded in the holotype, is situated slightly behind the interorbital line. The orbits are small (diameter 2.5 mm), circular, and anteriorly placed (Pl. 114, fig. 2); although close to the lateral margin of the shield, the eyes appear to have been dorsally, rather than laterally, directed. In the holotype and in NMC 21601, the lateral margins of the shield are underturned to form a ventro-lateral lamina extending back from the preorbital region; owing to the friable state of the skeletal material, preparation of these laminae proved impossible. No branchial lobes, notches, or openings are apparent.

Ornamentation is of uniformly high, closely spaced dentine ridges which are commonly less than 3 mm long; their local grouping into small units, separated by grooves or by rows of tubercles, produces a superficial subdivision of the shield (Pl. 114, figs. 1–3). This subdivision is absent from the rostral and lateral margins of the shield, around the orbits, and locally on the central part of the shield. The character of the units changes throughout the length of the shield. In the anterior third, each unit comprises peripheral ridges which are curved or grouped around a single median ridge (text-fig. 2*a*); divisions between the units are not very distinct, and the orientation of the median ridge varies widely. Within the posterior third of the shield, units are distinctly scale-like (text-figs. 2*f* and 3*b*). Each is in the form of a rhomb, approximately 1.5 × 1.5 mm, within which tubercles are placed in front of short ridges, in an arrangement similar to that of the detached body scales which are associated with the holotype (Pl. 114, fig. 1). The gradation from scale-like units to true body scales, at the posterior end of the headshield, makes the precise shape of the posterior margin of the shield uncertain. In the intervening part of the shield, between the anterior units with curved peripheral ridges and the posterior scale-like units, the ridges are only locally grouped into units. Where units are present, they comprise short (up to 3 mm), parallel ridges with a longitudinal arrangement (text-figs. 2*d*, 3*c*). In the absence of such units (text-fig. 2*e*), ridges vary in length up to a maximum of 10 mm.



TEXT-FIG. 2. *Corvaspis arctica* sp. nov. Variation in ornamentation of dorsal shield NMC 21600 (holotype).
Plan $\times 2$, detail $\times 12$.

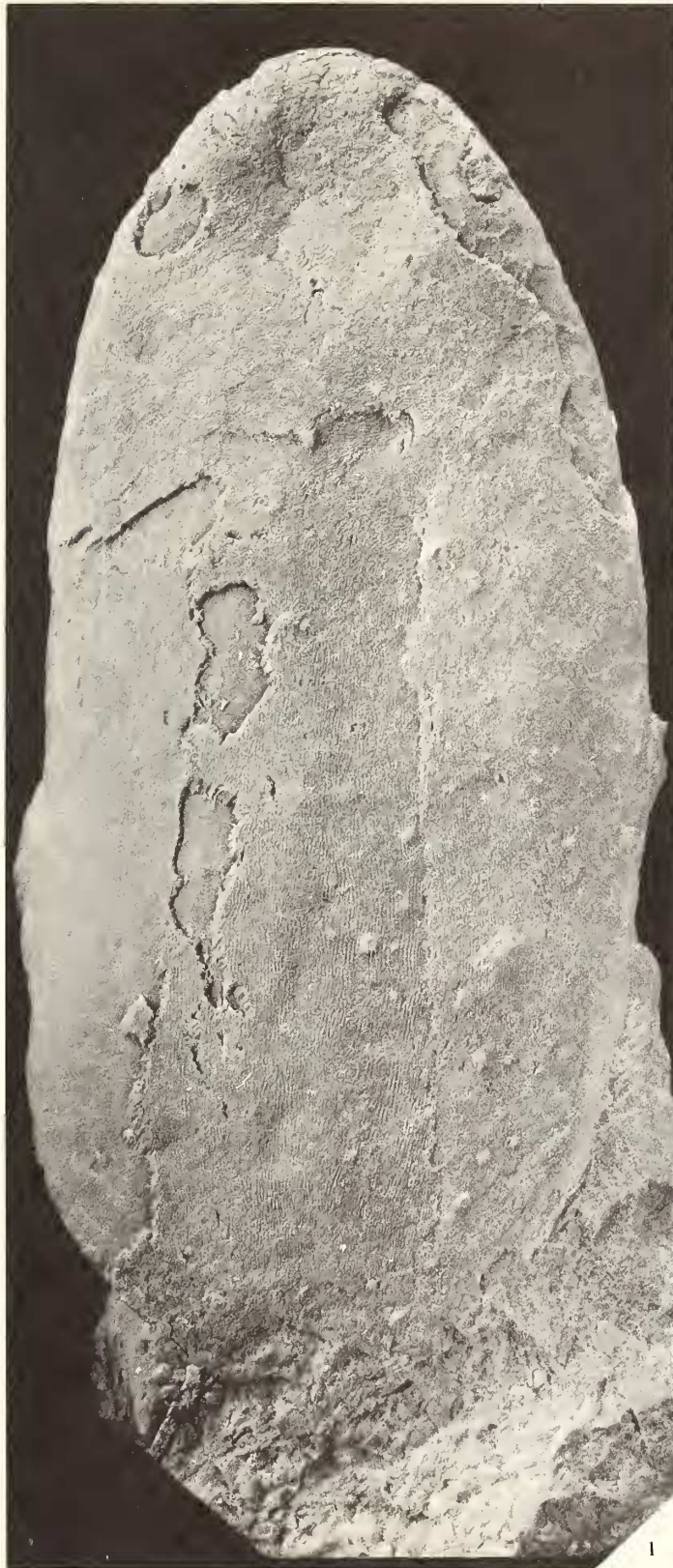
EXPLANATION OF PLATE 114

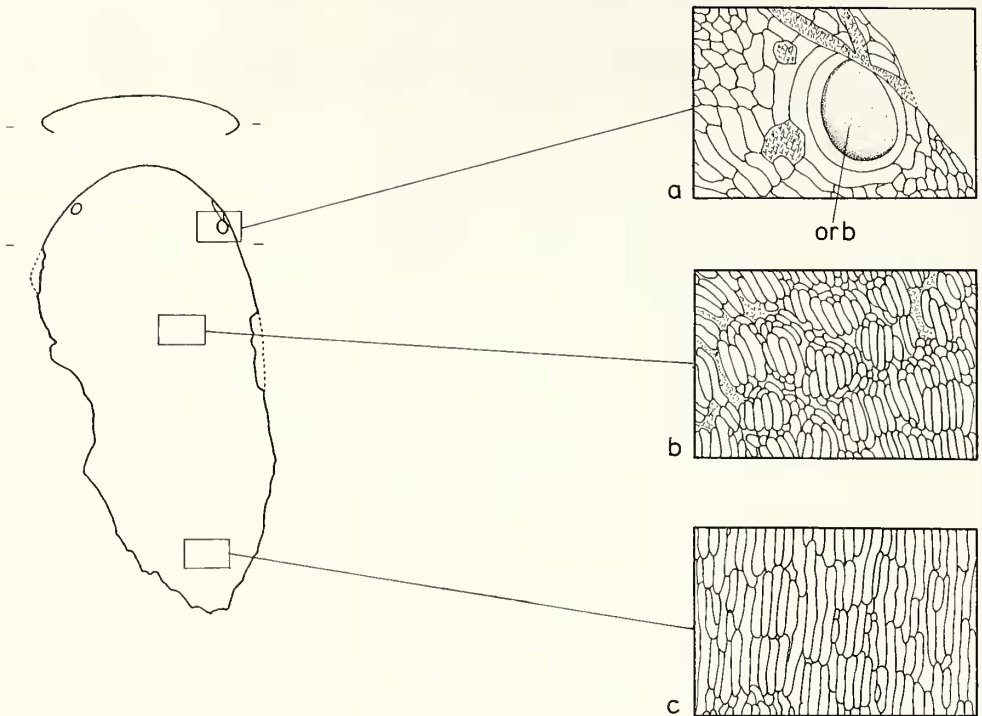
Corvaspis arctica sp. nov.

Fig. 1. NMC 21600 (holotype), incomplete dorsal shield associated with trunk scales. Magnification approx. $\times 2$.

Fig. 2. NMC 21601, incomplete dorsal shield. Magnification approx. $\times 1.5$.

Fig. 3. NMC 21602, incomplete dorsal shield. Magnification approx. $\times 1.5$.





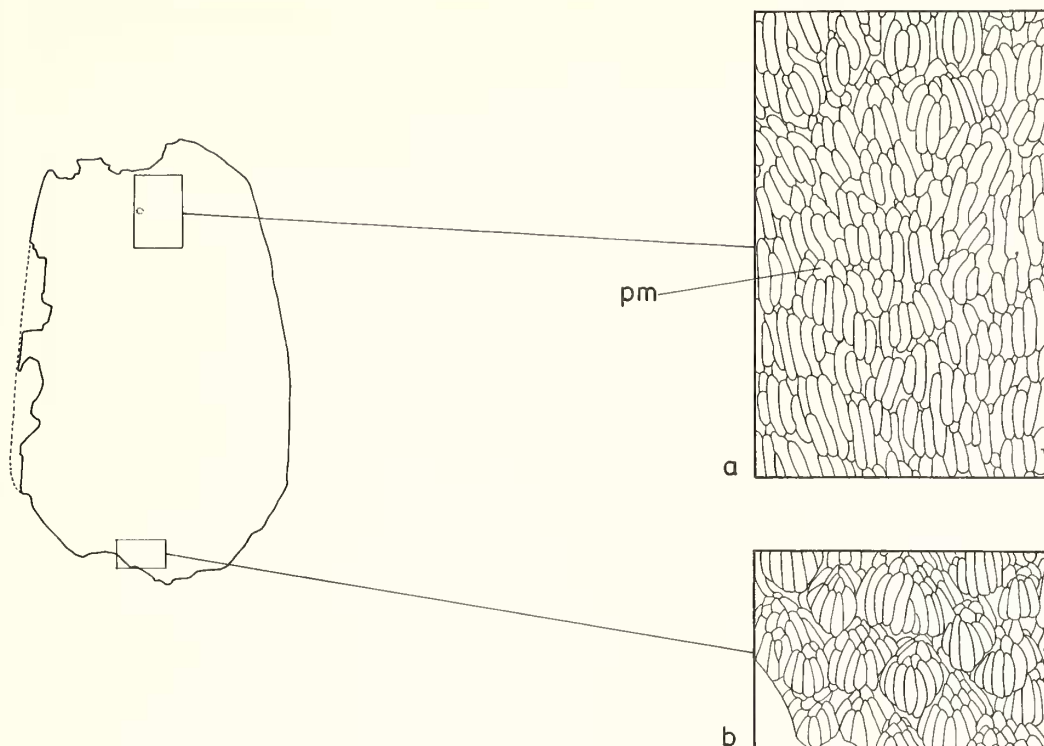
TEXT-FIG. 3. *Corvaspis arctica* sp. nov. Variation in ornamentation of dorsal shield NMC 21601. Plan $\times 1$, detail $\times 16$, orb, orbit.

The orbits, which are best preserved in NMC 21601 (Pl. 114, fig. 2), are encircled by two annular dentine ridges and by numerous short peripheral ridges and tubercles (text-fig. 3a). The concentric ornamentation of the orbital region grades into the typical ornamentation of the rostral region without obvious boundaries or sutures.

The pineal region of the holotype is poorly preserved, with broad (0.4 mm) ridges radiating from an abraded macula (text-fig. 2c). In NMC 21602, however, the macula is a small tubercle which does not disrupt the surrounding ornamentation (text-fig. 4a); it is slightly depressed, suggesting that the pineal region of the shield was particularly thin. The macula is not preserved in NMC 21601.

The ornamentation of the lateral and anterior margins of the dorsal shield is characterized by broader ridges and tubercles than occur elsewhere on the shield. On the rostral margin, the ornamentation is of short ridges and tubercles 0.4–0.8 mm wide (Pl. 114, figs. 1 and 2); in the holotype, these are so irregular and bulbous (text-fig. 2b) as to suggest a secondary origin. On the postorbital, lateral margins of the shield, ridges are up to 0.5 mm wide.

The numerous body scales which are associated with the holotype (Pl. 114, fig. 1) are small (1.5–2.0 mm in diameter) and rhomb-shaped. Ornamentation comprises several longitudinal ridges posteriorly, and a variable number of anterior tubercles. The anterior margin of each scale has an unornamented brim approximately 0.2 mm wide.



TEXT-FIG. 4. *Corvaspis arctica* sp. nov. Variation in ornamentation of dorsal shield NMC 21602. Plan $\times 1$, detail $\times 16$. pm, pineal macula.

Remarks. The form of the orbits, and the characteristic ornamentation of short ridges grouped into areas, indicate these specimens as members of the genus *Corvaspis* Woodward. They are distinguished from the three established species (*C. kingi* Woodward, *C. graticulata* Dineley, and *C. karatajuteae* Tarlo) by details of the ornamentation. The width of individual dentine ridges of *C. arctica* sp. nov. is less than that of the other species, and the variety of ornamentation is greater even than in *C. karatajuteae*; although scale-like subdivisions of the shield were described in *C. graticulata* (Dineley 1953), they are not as intricately ornamented as those of *C. arctica*.

MORPHOLOGY OF *CORVASPIS*

C. arctica, the first member of the genus to have been described from other than fragmentary remains, appears to have been a rather streamlined form with a long, narrow, flattish dorsal shield. Despite its similarity in over-all shape to certain of the larger cyathaspids (such as *Pionaspis* and *Ptomaspis*), the dorsal shield completely encloses the orbits, and extends to cover the ventral faces of the lateral margins of the cephalic region. The armour of the ventral surface of the head, including the oral

region, remains unknown; immediately behind the headshield, the trunk appears to have been covered by small imbricating scales.

Previous interpretations of the morphology of *Corvaspis*, based on the remains of *C. kingi*, produced a rather different picture from that outlined above. Dineley (1953) and Tarlo (1960), although differing over details, both visualized *Corvaspis* as a rather large, dorso-ventrally flattened ostracoderm not unlike *Drepanaspis*. Dineley (1953) recognized median, orbital, and ridge plates, postulating that a scaled area or mosaic of small plates surrounded the median disc. Tarlo (1960) with additional British material at his disposal, reinterpreted Dineley's 'ridge plates' as branchial plates and also described a postorbital plate; he inferred, from the pattern of ornamentation, that fields of tesserae (small plates) separated the main plates.

It is not possible to dismiss these accounts as merely being the result of work on fragmentary material. Although similarly shaped and ornamented fragments could be produced by mechanical breakdown of a dorsal shield similar to that of *C. arctica*, such a simple explanation does not appear to be the case. While some of the 'plates' described by Dineley (1953) and Tarlo (1960) could be fragments of larger plates, others show distinctive differences in histology and ornamentation at their margins (Dineley 1953, p. 177, fig. 16), which can consequently only be assumed to have been natural edges. If examples of this were confined to median plates, it might be possible to conclude that they were ventral plates, which are otherwise unknown. Tuberculated or spongy margins are, however, present on many of the asymmetrical plates, including the orbital and the postorbital plates (Tarlo 1960, pl. 37, figs. 2, 4, 7). Thus, although the over-all shape of the carapace may have been similar to that of *C. arctica*, the dorsal armour of *C. kingi* (and possibly also of the other two established species) was apparently divided into plates and tesserae.

Stratigraphic evidence suggests that subdivision of the dorsal armour into plates and tesserae was a late development within the genus; it may have been an adaptation to permit continued growth of the shield. If this was the case, the marginal spongy tissue (Dineley 1953) may have been the zone of active growth, the tuberculated borders marking the increased area. Such growth may account for the irregular shape of the plates, and for the 'incorporated tesserae' which were described by Tarlo (1960).

AFFINITIES OF *CORVASPIS*

When Woodward (1934) first described *C. kingi*, he regarded it as a cyathaspidid. Dineley (1953), however, describing additional British material, considered the enclosed orbits to justify establishing the family Corvaspididae. Stensiö (1958) subsequently suggested that it should be raised to the rank of an order, the Corvaspida. From work on new material from Britain, Tarlo (1960) concluded that *Corvaspis* was sufficiently close to *Drepanaspis* to be placed with it in the family Psammosteidae. In a subsequent revision of the psammosteids, Tarlo (1962, 1964, 1965) referred *Corvaspis* to the order Psammosteiformes, placing the Corvaspididae within the suborder Tesseraspida. He suggested (1960, 1962, 1964, 1965) that *Cardipeltis* had been derived from the primitive Psammosteiformes (such as *Tesseraspis* and *Kallostrakon*) via *Corvaspis*. The relationship between these forms was based on Tarlo's

interpretation of the ornamentation; the lineage was supposed to show progressive stages in the elimination of tesserae.

Following Thorsteinsson and Tozer's report (in Fortier *et al.* 1963) of a cyathaspidid comparing favourably with *Corvaspis*, both Obruchev (1964, 1967) and Halstead (1973) grouped *Corvaspis* with the cyathaspidids. Obruchev (1964) placed the Corvaspididae within the order Cyathaspidiformes, giving it equal status with the Tolypaspididae, Cyathaspididae, Poraspididae, Anglaspidae, and Ctenaspididae. Halstead (1973) provided a similar grouping, but accommodated *Anglaspis* within the Poraspididae, and proposed an evolutionary scheme whereby the cyathaspids and pteraspids were independently derived from tessellated ancestors. Within the cyathaspid lineage, *Corvaspis* was supposed to have been derived from *Kallostrakon* and to have given rise to *Cardipeltis* as well as to the cyathaspids.

C. arctica is closest in over-all appearance to some of the larger cyathaspidids such as *Pionaspis* and *Ptomaspis*, but differs in having enclosed orbits and a ventro-lateral lamina. It particularly resembles *Ptomaspis* in its ornamentation, showing a gradation from short dentine ridges anteriorly to scale-like areas posteriorly. Although Halstead (1973) proposed that *Corvaspis* was derived from *Kallostrakon* and gave rise to the cyathaspids, a shield like that of *C. arctica* could equally well have originated from a primitive, *Ptomaspis*-like, cyathaspidid shield by fusion of the suborbital and also possibly the branchial plate to the lateral margins of the dorsal shield. In view of the morphology of *C. arctica*, the derivation of *Cardipeltis* from *Corvaspis* is also open to question. *Cardipeltis* was shown by Denison (1966) to have been a broad, flat heterostracan with a short tail, a terminal mouth, and dorsal branchial openings which notched a median dorsal disc; small plates cover the rostrum and also form the ventral armour. The only features common to *Corvaspis arctica* and *Cardipeltis* are the short dentine ridges which comprise the ornamentation.

It remains to be shown whether the subdivision of the armour in *Corvaspis kingi* was an important evolutionary step towards the development of tesserate forms, or whether it is an example of the ease with which the shield could be 'mobilized' to permit continued growth.

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